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may be older or newer than those of the Marañon, and the Tertiary sea which left the shells at Pebas may or may not have been united with the ocean by a Lower Amazonian strait. Some facts in geographical distribution lead me to suppose that Guiana was then united to Central and Southern Brazil. In that case the Amazons may possibly have flowed westward into the Tertiary sea from some high land farther east.

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HIBERNATION OF THE LOWER VERTEBRATES.[1]

BY AMOS W. BUTLER.

IN a recent article in *Science* (Vol. IV, No. 75, pp. 36–39) Dr. C. C. Abbott gave the results of his observations of the hibernation of some of the lower vertebrates.

I have for several years, as opportunity offered, noted my observations in this line, and while my experience in some respects has been similar to that of Dr. Abbott, I feel that the results I have obtained may be appreciated by others similarly interested.

The climate of New Jersey and Southern Indiana is much the same; this fact will lead us to expect somewhat similar results from our observations.

The common box tortoise, called also "land tortoise" and "terrapin," according to locality, hibernates regularly in Southern Indiana. It frequents the drier woodland, partially overgrown with underbrush. It enters the ground in the latter part of September or early in October to a depth not exceeding a foot, the average being from eight to ten inches.

A few years ago, in March, I was burning over a track of woodland on which were a number of brush piles; when the fire burned out I passed by where some of the brush piles had been and noticed that the ground appeared to have been torn up as though a charge from a shot gun had been fired into it. Examination, in several instances, revealed the fact that the work had been done by tortoises. The heat having penetrated to the depth of their winter quarters and aroused them from their winter's sleep, they now sought the surface and the cause of their sudden awakening.

The day being quite cool I placed them in a beaten road which passed through the woods and awaited further proceedings; they appeared to realize that they had entered upon their summer career too soon, and a few moments saw them all safely buried beneath neighboring brush piles and bunches of leaves.

The box tortoise emerges from its winter quarters late in April or early in May.

Mud turtles, including all the river and pond turtles, hibernate in this locality, but there will, no doubt, be occasional exceptions found to this rule.

The "soft-shelled" turtles burrow deep into the mud, while their "hard-shelled" relatives are not so susceptible to climatic changes, and their wintering places are not at such a depth.

I have under my charge a water-power canal fourteen miles long, parts of which are thickly populated by turtles. In the winter time while making repairs, "hard-shelled" turtles are often found at a depth of four to twelve inches beneath the earth in the bed of the canal; when one is found we feel quite confident of finding from two to four companions near by. Many turtles frequent little coves along the banks of the canal, where the water is from two to three feet deep; these indentures are generally made by muskrats; in repairing the destruction they cause as many as three or four "hard shells" are sometimes taken from their muddy quarters.

The White-Water rivers are very clear in winter, enabling one to examine even their deeper portions to advantage. I have never been able to hear of an instance where a turtle has been seen even in the deepest water; besides, the deeper pools are seined almost every winter, and I have been unable to learn of a turtle ever having been drawn out in a seine at that time of the year.

My fellow-worker, Mr. E. R. Quick, gives me some notes which are exceptions to the rule of hibernation just mentioned. He says: "I have known mud turtles (*Aromochelys odoratus* Latreille) to leave ponds which became dry in the winter time and go to the river near by. In the winter of 1874–5 I saw the tracks of a large turtle in the snow leading from the bed of a pond which had become dry, to the river a short distance away. I think the tracks were made while the snow was melting."

The above instances appear to indicate that the act of hibernation is voluntary to a certain extent. I have found "hard-shelled" turtles that had been left at some distance from the river by winter floods; they appeared dead, but when brought to a fire became quite active. "Soft-shell" turtles always die when thus thrown out by rises in the river in winter.

Our more tender fish hibernate, but there are many hardy species that frequent the deeper pools of our rivers and are caught in large numbers by means of seines and nets let down through the ice.

The species most commonly caught in this manner are quillbacks (*Carpoides velifer* Rafinesque, and *C. cutisanserinus* Cope), white sucker (*Catostomus teres* LeS.) and the "hog sucker" or "molly-hog" (*C. nigricans* LeS.). The latter is apparently the hardiest of our fishes, being found in winter in shallow water of from six to twelve inches in depth. When the ice is three or four inches thick and clear, many "molly hogs" are caught in the following manner: The fisherman walks slowly along the edge of the river on the ice, keeping a close lookout for fish, which will be seen just beneath the ice; a heavy blow with an axe immediately above where they are either kills or stuns them; hastily cutting a hole in the ice the fisherman throws his fish out and proceeds in search of another. By this method, some winters, great quantities of fish are caught.

The common toad regularly hibernates, in sandy soil burrowing to the depth of eighteen inches, in clayey ground the average depth attained is about eight inches. They frequent gardens and are often found in their burrows in autumn by the gardener when burying garden produce and apples. In early spring they are frequently thrown out by the spade during early gardening, and in a few moments hop off apparently without impediment.

Frogs are, at times, found some distance from water, passing the winters burrowing in damp places.

Early last spring when clearing out a cellar window two leopard frogs (*Rana halecina* Kalm) were found burrowed beneath the accumulation of the past year. The weather was quite cool and the frogs appeared to be dead, but when taken into a warm room they soon revived and began croaking. The locality where these frogs were found is on a ridge about seventy-five feet high and over three hundred yards from the river.

As a rule newts and salamanders do not enter the ground but spend the winter in springs and beneath leaves and logs in the damper woods. I have found them in winter, when the springs were not frozen, to be quite active. I have taken the common newt on several occasions in damp woods, under logs, when they appear to be frozen, but when placed in the sun or held in the hand a short time would revive. Early in March the woodland ponds of this vicinity teem with salamanders of different species.

In this part of the Ohio valley, as a rule, tortoises, turtles, toads and frogs are found hibernating; on the other hand the newts, salamanders and many species of fish do not enter a torpid state.

Exceptions to these rules will doubtless occasionally be noticed, but from the present state of our knowledge of the life-histories of these animals they hold good.

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THE AMBLYPODA.

BY E. D. COPE.

(Continued from page 1202, Vol. xviii.)

DINOCERATA.

IN this suborder we have a series of mammals which are in some respects the most remarkable that have ever existed. This is true whether we regard the bizarre appearance of their skulls, their dentition, so weak when compared with the bulk of their bodies, or the insignificant size of their brain. We only know them as yet from the Bridger or Upper Eocene formation of North America, with a species possibly from the Wasatch or Lower Eocene.

The characters of this suborder have been already pointed out (Vol. XVIII, p. 1121). The differences from the Pantodonta are well marked, but the resemblances are such as to render it impossible to refer the Dinocerata to a different order. Their strong resemblances to the Proboscidia are generally admitted, but the few characters which distinguish them are of the first importance. These are, first, the very small size of the brain, especially of the cerebral hemispheres; and second, the double distal articulation of the astragalus, where the facet for the cuboid bone is nearly as large as that for the navicular.

Within the above definition there is room for much variation, which, however, the known genera do not display. They agree in various points of minor importance. Thus there is no sagittal